Process Particle Counter to Optimize Power-Recovery Expander and Gas-Turbine Performance

A new particle-size and concentration monitor leads to efficient use of lower-quality fuels

Benefits

- Could save 20 billion Btu of natural gas per installation annually
- Could save 5.1 trillion Btu annually by 2010
- Allows high-efficiency turbines to be installed in more applications
- Decreases emissions by improving power-generation efficiency
- Protects turbines from high particulate concentrations that lead to blade wear
- Reduces production downtime from failures caused by particulate contamination

Applications

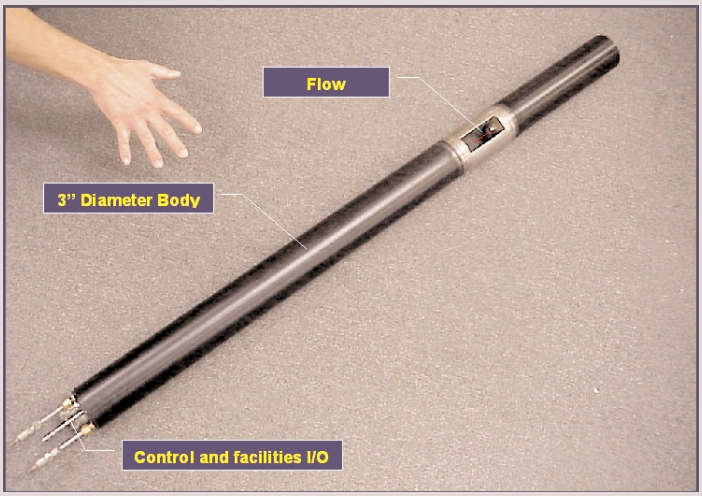
Process particle counters are applicable in petroleum power generation both for existing power recovery expanders and in situations where power recovery expanders have not been used because of unreliable fuel quality and return on investment concerns. Process particle counters broaden the applicability of the power-recovery expander and can be applied to gas turbines used for power generation in industry and on ships. The technology also can provide particulate control and monitoring for forest products and agricultural biomass in fuel generation, applications where inorganic particulate loads are severe.

Both gas turbines and power-recovery expanders used in petroleum power generation are efficient energy-conversion devices, yet fuel quality limits the application of these technologies. Widely available low-cost fuels generally contain more contaminants, which can lead to system fouling and wear as well as downtime for repair and cleaning. Without continuous monitoring for particulate contamination and feedback control, systems must be set for unknown conditions, so the more-efficient gas turbines and power-recovery expanders are not installed or, if installed, operate at lower efficiency.

Currently no cost-effective technology exists for real-time continuous particle monitoring for the expander or gas turbine industries. Low sensitivity or slow gravimetric techniques are currently used for monitoring. To function efficiently, other particle-monitoring technology requires skilled instrument operators.

The process particle counter (PPC) uses optical technology with fixed alignment to provide a continuous, real-time, robust, stand-alone particulate monitor that allows expanders and gas turbines to operate closer to optimum conditions. Such conditions improve efficiency while protecting turbines, allowing use of lower-quality fuels. The PPC technology expands applications for efficient power generation using power-recovery expanders and gas turbines.

Process Particle Counter



The new process particle counter, being developed by Process Metrix, LLC, uses optical technology to provide real-time continuous monitoring of particulates in energy-conversion devices.

Project Description

Goal: Develop a single-beam, fixed-alignment PPC/sizer as an automated long-term sensor and control system for dust monitoring of power-recovery expanders and gas turbines.

The PPC measures particle size and concentration and provides a feedback-control system for monitoring particulate contamination and resulting blade wear in gas turbines and power-recovery expanders. In this system, an optical sensor using a simple single-beam, fixed-alignment system is robust and acts as a stand-alone system that does not require an operator. The technology provides data and analysis at 1- to 10-second intervals suitable for real-time monitoring.

The feedback-control device protects turbines from high particle loading that leads to blade wear and efficiency reductions. The PPC technology allows less expensive more widely available fuels to be used that can contain contaminants that lead to system inefficiency. The sensor technology allows high-efficiency expanders and turbines to be installed in applications that were previously considered too risky because of lower-quality fuel sources.

Process Metrix, LLC, is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the U.S. Department of Energy's Office of Industrial Technologies.

Progress and Milestones

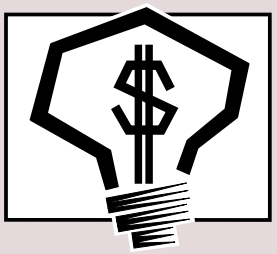
- Perform short-term field measurements with existing expanders and gas turbines to provide basic particle size and concentration parameters.
- Determine appropriate instrument interface with turbine systems.
- Design and fabricate a prototype PPC, based on field characterization results.
- Field test the PPC prototype for short- and long-term performance validation.
- Develop a plan for marketing the PPC to target industries.

Economics and Commercial Potential

The PPC is expected to improve operating efficiencies of power-recovery expanders and gas turbines by 3% to 5%. Using conservative assumptions for efficiency improvement, a 5-month payback time is predicted for a $50,000 instrument investment. The payback for installing PPC technology could be achieved in as little as one day of avoided refinery downtime caused by system failure.

The technology not only saves energy by using the PPC but also enables wider application of more efficient power-generating, power-recovery expanders and gas turbines. Market penetration to date for power-recovery expanders has been less than 50% of potential refinery applications, despite the 25% generation efficiency improvement potential the technology offers. Combining PPC technology with power-recovery expanders can help reduce performance uncertainty and provide a clearly defined payback for expander installation, broadening both the market for the technology and the potential for energy savings.

Marketing the PPC technology will initially focus on use by collaborating partners. Although a niche market, the market size and potential for energy savings are both significant. The current market for the enabling technology is assessed at 1000 units, or 10% of the existing 10,000 turbine and expander applications that justify real-time sensors, a $50 million market at a unit cost of $50,000 each. Market capture for the PPC technology is anticipated to be 3% in the first 2 years. This technology could save an average of 20.1 billion Btu of natural gas per installation annually. First sales for the technology are expected by 2003. Based on 25% market penetration by 2010, annual savings could be 5.1 trillion Btu with 250 units operating. Market penetration of 75% by 2020 could save 15.2 trillion Btu from operations at 750 units.



The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

FOR PROJECT INFORMATION, CONTACT:

Donald J. Holve
Process Metrix LLC
2110 Omega Rd., Ste. D
San Ramon, CA 94583
Phone: (925) 837-1330
Fax: (925) 837-3864
dholve@processmetrix.com

FOR PROGRAM INFORMATION, CONTACT:

Lisa Barnett
Program Manager
Inventions & Innovation Program
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585-0121
Phone: (202) 586-2212
Fax: (202) 586-7114
lisa.barnett@ee.doe.gov

FOR PROJECT UPDATES:

Visit our home page at
www.oit.doe.gov/inventions

Office of Industrial Technologies
Energy Efficiency
and Renewable Energy
U.S. Department of Energy
Washington, DC 20585-0121

Order# I-OT-802
September 2001